



Tevatron End of Run Studies Plan

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Motivation and History

- Over the course of Run II, Tevatron was successfully used to develop new accelerator/beam physics concepts: electron lens for beam-beam compensation, novel methods of optics measurements, crystal collimation, hollow electron beam collimation, etc.
 - Most of the studies were performed parasitically during HEP stores or made use of end of store time.
- There is strong interest from FNAL, CERN/LHC/LARP, BNL to explore a number of accelerator physics topics at Tevatron before it is switched off forever
 - Many require special beam conditions conflicting with HEP operation
- Originally, the idea was to perform studies both during collider run and have a dedicated program after Run II (“open” time between October 1, 2011 and NOvA shutdown)
- Since the Run II extension denied, the decision was made to schedule periods of studies during the collider run



Motivation and History continued

- Tevatron Accelerator Studies Workshop (*January 13-14, 2010*)
 - <https://indico.fnal.gov/conferenceOtherViews.py?view=standard&confId=2921>
 - Generated long list of studies to be considered, rough plans
- Fermilab AAC meeting (*July 28-30, 2010*)
 - <https://indico.fnal.gov/conferenceDisplay.py?confId=3475>
 - Strong support for an accelerator studies program
- DOE Institutional Review of Fermilab (June 6-9, 2011)
 - <https://indico.fnal.gov/conferenceDisplay.py?confId=4263>
 - Support of the proposed accelerator studies



Motivation and History continued

- Guidelines for the Accelerator Studies Program were outlined by R.Moore in a AEM talk on February 14, 2011
 - http://www.fnal.gov/directorate/program_planning/all_experimenter_meetings/special_reports/Moore_TevStudies_02_14_11.pdf
 - Prioritized the list of studies and consolidated into blocks requiring similar beam conditions
- First period for experiments with Crystal Collimation and Hollow Electron Beam – two weeks in May, 2011
 - See D.Still's AEM talk:
http://www.fnal.gov/directorate/program_planning/all_experimenter_meetings/special_reports/Still_T980%20Pixel_06-13-11.ppt
 - Excellent results + still integrated luminosity at a good rate
- Collimation with Hollow Electron Beam – parasitic during HEP
 - See G.Stancari's AEM talk:
http://www.fnal.gov/directorate/program_planning/all_experimenter_meetings/special_reports/Stancari_Hollow_Electron_beam_07_25_11.pdf
 - Demonstrated viability of the concept, many good results in a short period of time



Current Study Period – 8/15-26

- The experiments during this period are devoted to studies of **beam-beam effects**
 - Strong interest from CERN/LHC and BNL/RHIC – the two current hadron colliders. Five experts from CERN, BNL, LBNL are here to participate
 - A number of unanswered questions in the Tevatron beam physics
- These studies require special beam conditions
 - 3x3 or 1x1 colliding stores – this makes the beam-beam system simpler and allows to simulate the experiments reliably
 - Some of the studies require excitation of the beam motion, potentially generating losses – less likely to cause a quench with small intensity



List of Topics

1. AC Dipole with colliding beams

- AC dipole is a device that **adiabatically** excites transverse oscillations of the beam. Turn-by-turn detection of oscillations at the excitation frequency allows to restore the beam optics.
 - This technology was in part developed at the Tevatron (M.Syphers, A.Jansson, R.Miyamoto)
 - AC dipole is THE method used to measure LHC beam optics
 - CERN is interested to explore the possibility to use the method while the beams are in collision

2. Coherent Beam-Beam Modes

- Colliding beams represent a system of coupled oscillators with their eigenfrequencies determined by beam and machine properties.
 - The modes are an important tool for diagnostics
 - In some circumstances, the modes can become unstable
 - There are conflicting results from different simulations, and the experiment will provide an ultimate benchmark



List of Topics continued

3. Beam-Beam Resonances vs Separation
 - Study the importance of transverse beam-beam misalignment
 - There are conflicting results from different simulations, and the experiment will provide an ultimate benchmark
4. Betatron Phase Averaging
 - Theory predicts that the magnitude of beam-beam effects is strongly affected by the ratio of transverse beta-function to the bunch length.
 - The goal is to collide bunches at several values of β^*/σ_z and measure the effect on beam and emittance life time.
5. Diffusion Driven by Beam-Beam Resonances
 - Beam-beam effects interplay with other diffusion and noise sources
 - The goal is to introduce diffusion of varying magnitude and measure the relative effect of beam-beam on the beam life time.



Organization and Scheduling

- We have requested 40 hours of beam time over the two week period
 - This will be split into 8-hour shifts, each consisting of 2 to 3 3x3 stores
 - The 8-hour periods are scheduled every other day with normal HEP running in between. The Tevatron will be used 'as is', only the beam configuration is different from the nominal.
 - Plan for the day will be discussed and decided at the 9AM meeting
 - Some studies will provide stable beam conditions, and will allow experiments to take data
 - Tentative schedule is posted at http://www-bdnew.fnal.gov/tevatron/projects/crystal_collimator/2011_aug_2_weeks_study_plan.html
- A technical note summarizing the results will be published